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Tennessee Academy of Science

ABSTRACTS PRESENTED AT THE ANNUAL MEETING

BOTANY SECTION
Thomas E. Byrne, *presiding*

A Comparison of Two Species of Trachelomonas *(Euglenophyceae) With Scanning Electron Microscopy,* T.E. Byrne, Roane State Community College.

Scanning electron microscopy was used for examination of the surface of *Trachelomonas variabilis* Singh and *Trachelomonas volvocinopsis* var. spiralis Pringsheim. Specimens of both species were examined with air dried and critical point dried (CPD) techniques. In *T. variabilis* the CPD specimens revealed greater resolution of structures comprising the lorica, whereas the air dried specimen displayed distortion and obscurement of finer details of the structure. Envelopes of algal flagellates have been widely used as taxonomic criteria. Comparison of *T. variabilis* with *T. volvocinopsis* revealed that both species possess ovoid, papillate, punctate loricas with a small collar. The spines of *T. variabilis* appear tapered and at right angles to the lorica, while the spines of *T. volvocinopsis* are rounded and are not set perpendicular to the lorica. The lorica was observed in both cases to be composed of fibrillar components with mucilaginous strands. Part I of this topic was reported in the *Journal of the Tennessee Academy of Science,* Volume 62, Number 3, July 1987.

A Statistical Technique for Multiple Comparisons of Diversity Indices, W.P. Winston, Tennessee Technological University.

Species diversity indices are often used to describe or evaluate the structure of animal and plant assemblages, but there is no rigorous method of statistically comparing more than two communities. This paper describes a technique employing the computation of an F-statistic, comparing the among-group variation to within- group variation of Shannon diversity indices according to the following formulae, respectively:

$$n_i(H' - H_i')^2/(k - 1)$$

$$(\sum_{i=1}^{k} f_i \log f_i)^2/N - \sum_{i=1}^{k} \log^2 f_i/N^2$$

The computed F-statistic is compared to a critical F with $k-1$ and $N-1$ degrees of freedom. If significant differences exist, the diversity indices are subjected to a Tukey-type (or other appropriate multiple comparison) test. This analysis can be used to evaluate structural differences among communities in different ecosystems, changes in structure over time (e.g., seral stages of succession) or changes which occur as a result of perturbation.

Some Aspects of Northwestern Middle Tennessee Barrens, E.W. Chester, Austin Peay State University.

At the time of settlement, extensive areas of upland, level to rolling lands in northern Montgomery, Robertson, and Stewart counties were vegetated by grasslands interspersed with scrubby oak forests and swamps. The European settlers referred to these areas as barrens because of the lack of trees and water, choosing peripheral sites closer to timber and permanent streams for their farms and towns. The presence of numerous prairie species in the

barrens flora has long been observed and they have often been considered as part of the Prairie Peninsula. Most now believe that the presettlement vegetation was not climax and was more likely fire-maintained. The barrens are now under agricultural stress or have been otherwise altered so that only remnants of the original vegetation remain. This report, based on observations since 1962, provides a characterization of the barrens and their flora as they exist today.

Chromosome Stability in Soybean Cultures, E.L. Myles, P.S. Kahlon, S.M. Bhatti, Tennessee State University.

Cytological investigations of soybean *(Glycine max L.)* cv. Pella were conducted. Callus obtained from hypocotyl sections of seedlings callus were used to initiate suspension cultures. Cultures were maintained in Murashige and Skoog's medium (1962) supplemented with 2 mg/L 2,4-Dichlorophenoxyacetic acid. The mitotic index was increased by exposing the suspension culture to 0.02% colchicine for 3 hours. Prometaphase and metaphase chromosomes were observed for numerical and structural changes. Although structural changes were not detected our results showed an aneuploid rate of 59% with only 41% of the cells preserving the normal chromosome complement of 40. The chromosome number in the aneuploid cells ranged from 50 to 70 chromosomes per cell. These results show that *G. max* cv. Pella did not maintain chromosome stability in suspension culture. (Supported by USDA/CSRA grant #TENX-8503-7-PS19).

Induction of Embryogenesis From Immature Soybean Seeds, S.M. Bhatti, P.S. Kahlon, E.L. Myles, Tennessee State University.

Immature seeds of five cultivars of soybean were evaluated for their embryogenic capability. Seeds ranging in size from 1–7 mm were used as explant sources. Cotyledons and embryos were cultured separately on different combinations of growth hormones. The hormones, naphthalene acetic acid (NAA), 2,4-Dichlorophenoxyacetic acid (2,4-D), Indole Butyric Acid (IBA), kinetin, Abscisic Acid (ABA) and Benzyladenine (BA), were used in ten different combinations. Observations were taken every two weeks for the appearance of organized tissue. Results at the end of the four week growth period showed that cotyledons excised from seeds less than 2 mm in length did not show any sign of callus growth. Somatic embryos were observed only in seeds ranging from 3–5 mm in size. Cotyledons and embryos from cultivars Hills, Essex and Forest formed somatic embryos on MS media supplemented with 10 mg/L 2,4-D with or without ABA. All the other hormone combinations induced callus formation only. Transfer of embryogenic callus on media supplemented with 5 mg/L 2,4-D induced more somatic embryos. (Supported by USDA/CSRS grant #TENX-8503-7-PS19).

Effects of Ca Antagonist on GA Enhanced Lettuce Seedling Hypocotyl Elongation, B.P. Stone, Austin Peay State University.

Trifluoperazine, chlorpromazine, tetracaine, cobaltchloride and diethylstilbestrol reversed GA enhanced lettuce seedling hypocotyl elongation. The interaction of $CaCl_2$ and the calcium ionophore A23187 with Ca antagonist reversal of GA enhanced hypocotyl elongation will be discussed.

Vegetation Studies in a Stewart County Mixed Oak–Short Leaf Pine Stand, J. Schibig, Volunteer State Community College and E.W. Chester, Austin Peay State University.

Several naturally-occurring stands of mixed oak–shortleaf pine occur in Stewart County, northwestern Middle Tennessee. Best development is on dry, narrow, cherty ridges just east of the Tennessee River and within the TVA-managed Land Between the Lakes. These stands are significant, not only because of the rarity of such communities in that part of Tennessee and the Interior Low Plateaus, but also because they are now within public domain and can be protected. Thus, they provide ideal conditions for long-term research on such factors as edaphic control, changes in composition with time, and the effects of prescribed burning. This study characterizes the site and provides baseline data on community composition, based on plot studies during 1986–87. Preliminary data indicate dominance by *Pinus echinata* and such oaks as *Quercus alba, Q. coccinea, Q. marilandica, Q. prinus, Q. stellata,* and *Q. velutina.*

Changes in Indoleacetaldehyde Dehydrogenase Levels in the Presence of TIBA and PA during Morphogenesis in Tissue Culture, J.W. Harris and S.K. Ballal, Tennessee Technological University.

Explants of *Exacum affine* Balf. (German violet) were established and induced to undergo morphogenesis in tissue culture. Samples from cultures which had been independently given 24 hour exposures to the antiauxins TIBA and PA were extracted and subjected to cellulose acetate electrophoresis. Incubation for indoleacetaldehyde dehydrogenase isozymes revealed diminished enzyme activity for the antiauxin treated cultures as compared to the control.

Analysis of Simmondsia chinensis *Proteins by Polyacrylamide Gel Electrophoresis,* M. Bailey, S. Goss and S.K. Ballal, Tennessee Technological University.

The molecular weights of proteins in jojoba *(Sim-*

mondsia chinensis) seeds were estimated by SDS-PAGE. Two preparations of seed meal were analyzed; one with intact seeds and the other with the seed coats removed. Protein extracts were prepared from lipid-free seed meal by sequential solvent extraction and by single solvent extraction of trichloroacetic acid precipitates. Results indicate a hererogeneous group of polypeptides ranging in molecular weight from 70 KD to 5 KD.

A Population Survey of the Federally Endangered Pityopsis ruthii, Ruth's Golden Aster, J.L. Collins, Tennessee Valley Authority, and S.C. Gunn, Tennessee Department of Conservation.

The federally endangered *Pityopsis ruthii* (Asteraceae) is known only from populations along the Hiwassee and Ocoee rivers in Polk County, Tennessee. A baseline survey of the Hiwassee River population begun in 1986 is continued. Two existing permanent 10 by 10 m plots were revisited, and a third similar plot was established. Ten permanent 1 by 1 m quadrats were established at each of two sites on the Ocoee River. Information on both populations is reported, including observed probable effects of drought and the occurrence of *P. ruthii* on other than phyllitic rock.

CHEMISTRY SECTION
Karen Phiester, Presiding

Theory of Electrical Effects in Micelle Formation, R.P. Robertson, H. J. Wayt, and D. J. Wilson, Vanderbilt University.

Mathematical models for spherical micelle formation in solutions of ionic surfactants such as sodium dodecyl sulfate are developed and examined. These are able to predict the dependences of the critical micelle concentration on added salt concentration, on hydrocarbon chain length of the surfactant, and on temperature, with varying degrees of success. The models can be extended to the treatment of mixed micelles and micellar solubilization, which may make them of use in the examination of surfactant flushing of soils contaminated with hydrophobic toxic chemicals.

Absolute Configuration of (S)p-(+)-1,6-Methano [10] Annulene-2-Carboxylic Acid, M. V. Stewart, Middle Tennessee State University.

A single-crystal X-ray structure determination of the dextrorotatory salt formed from (S)-(–)-p-bromo-a-phenethylamine and (S)p-(+)-1,6-methano[10] annulene-2-carboxylic acid established the absolute configuration of the planar chiral carboxylic acid by virtue of the internal-reference chiral center provided by the cationic moiety. The quaternary nitrogen was distinguished from the isoe-

lectronic $(f_0 = 6e^-)$ carbon of the structurally analogous methyl group by its involvement in a continuous hydrogen-bonding scheme. Other computational methods for this stereochemically crucial atom assignment were applied to provide a useful perspective for judging their application to other crystal structures where intermolecular packing considerations alone do not afford an unambiguously correct choice.

Soil Clean-up by In-Situ Aeration.I.Mathematical Modeling, D. J. Wilson, Vanderbilt University.

Mathematical models are developed for evaluating the feasibility of in-situ vapor stripping of volatile chemicals from soil at hazardous waste sites. Laboratory soil stripping columns and field scale vacuum extraction wells are simulated. The effect of anisotropic Darcy's constants are examined, and compressibility of the extracting gas is taken into account. The models assume local equilibrium between the condensed and vapor phases, and may use Henry's Law or more complex isotherms. A method is developed for calculating Henry's constants from lab column data; use of Henry's constants from lab data on solutions of volatile solutes in pure water can lead to serious errors. Vacuum extraction wells should be screened only down near the impermeable layer beneath the zone of stripping (unsaturated zone) for most efficient functioning.

An Easier Route to Chemical Information, E. A. Kline, Tennessee Technological University.

The developments of online searching over a period of 20 years and more recently of graphics has greatly improved the efficiency of online chemical information searching. Academic discounts by STN (ACS) has allowed the teaching of online searching to undergraduates. Some preliminary studies show that a major number of citations in the most used chemical journal (J.Am.Chem.Soc.) and J.Chem.Ed are later than 1967. As information increases in both amounts and forms, it is essential to find better ways to cover the information. An algorithm, accompanied with a database allows for quicker and more complete selection of appropriate sources of information.

Copper (II) Complexes of Anti-Inflammatory Agents, M.D. Joesten, A.S. Bassin, S.M. Murphy, C.F. Schmidt, J.M. Schultz, B.O. Hill, H. Crusberg, J.A. Banton, D.R. Glover, J. Deaton, Vanderbilt University.

General chemistry students who received a B or better in the first term were invited to take part in a non-credit research project with weekly meetings on Friday afternoons during the spring term of 1987. The nine students who decided to take part in the project were divided into

three research groups. The research objective of each group was to synthesize and characterize new copper (II) complexes of antiinflammatory agents, following published procedures for copper (II) complexes of aspirin and ibuprofen. The research groups first prepared $Cu_2(aspirinate)_4$ and $Cu_2(ibuprofenate)_4$ following published procedures. Then, each group proceeded to attempt the synthesis of the Cu(II) complex of the antiinflammatory agent assigned to their group. The three antiinflammatory agents chosen for this study included indomethacin, naproxen, and mefenamic acid. Complexes isolated and characterized included $Cu(indomethacin)_2 \cdot 2H_2O$, $Cu(mefenamate)_2 \cdot 2H_2O$, and $Cu(naproxenate)_4$.

X-Ray Crystal Structures of Two Novel Silylmagnesium-Silylmercurate Complexes, W.H. Ilsley, A.F.M. Maqsudur Rahman, E.A. Sadurski, and J.P. Oliver, Middle Tennessee State University.

The X-ray crystal structures of the two compounds $(Mg(SiMe_3)(DME)_2)^+((Hg(SiMe_3)_3)_2)((Hg(SiMe_3)_3))^-$, *1*, and $(Mg_4(OCH_2CH_2OCH_3)_6(DME)_2)(Hg(SiMe_2Ph)_3)_2$, *2*, will be discussed. Compound *1*, obtained from the reaction of $Hg(SiMe_3)_2$ with $Mg(SiMe_3)_2 \cdot 2DME$ at elevated temperature, crystallizes in the space group Pn with cell constants of a = 14.872(4) Å, b = 10.136(5) Å, c = 16.337(6) Å, β = 100.46(3)°, V = 2422(2) Å^3 and Z = 2. The compound consists of a 5-coordinate $(Mg(SiMe_3)(DME)_2)^+$ cation, that can be described as a distorted trigonal bipyramid, a $(Hg(SiMe_3)_3)^-$ anion and a $Hg(SiMe_3)_2$ molecule with a Hg-Hg separation of only 2.965(3) Å. Compound *2* exists in two monoclinic crystalling forms, one with space group P2$_1$/c, having lattice constants a = 11.963(2) Å, b = 17.116(6) Å, c = 24.025(9) Å, β = 106.33(2)° and V = 4721 Å^3, *2a*, and the other having space group P2$_1$/n, with lattice constants a = 16.288(3) Å, b = 24.159(5) Å, c = 12.159(3) Å, β = 101.58(2)° and V = 4687 Å^3, *2b*. Both forms are composed of discrete $(Mg(OCH_2CH_2OCH_3)_6(DME)_2)^{2+}$ cations and $Hg(SiMe_2Ph)_3^-$ anions. The $Hg(SiMe_2Ph)_3^-$ ion exhibits trigonal planar geometry about the mercury, Hg-Si$_{av}$ = 2.508(6) Å and 2.515(6) Å in *2a* and *2b*, respectively. The cation consists of two symmetry related pairs of magnesium atoms participating in two distinctly different u-oxo-bridges: two symmetry related Mg-O-Mg bridges, Mg-O$_{av}$ = 1.99(1) Å and 2.10(1) Å in *2a* and *2b*, respectively, and two symmetry related Mg$_3$-u-O bridges, Mg-O$_{av}$ = 2.11(1) Å and 2.10(1) Å in *2a* and *2b*.

Proton Relaxation Times of Micellized and Adsorbed Surfactants, M. Sarker and D. J. Wilson, Vanderbilt University.

Proton longitudinal relaxation times were measured for dodecyltrimethylammonium chloride (DTAC), do-decylammonium chloride, and sodium dodecylsulfate solutions in D20. Effects of added paramagnetic and diamagnetic salts on the various relaxation times were determined and interpreted in terms of the structures of the micelles. Relaxation times of DTAC adsorbed on Al(OD)3-FeS floc were also determined and interpreted.

A Study of the Excited States of the Sodium Dimer, P.A. Kilzer and H.A. Kurtz, Memphis State University.

Calculations are presented for the excited states of the sodium dimer using the polarization propagator method combined with the use of effective core potentials. The propagator method is based on an antisymmetrized geminal power (AGP) wavefunction for the reference state. The effective core potentials used replace the core electrons in the Hamiltonian, thereby reducing the computational effort involved. The results shown will include dissociation energies, potential energy curves, transition moments, and radiative lifetimes. The use of several different basis sets will be employed.

Development of High-Resolution Thermal Denaturation of DNA Using a Hewlitt Packard Diode Array Spectrophotometer, J. C. Howard and B. K. Stringer, Middle Tennessee State University.

The requirements of instrument stability and temperature control for high-resolution thermal denaturation of DNA will be discussed and compared with the stability available using a Hewlett-Packard® diode array spectrophotometer and temperature control using a Haake® A-81 circulator. Results obtained on 1 DNA using our system will be compared with those published in the literature by the originators of the technique, Ansevin and Vizard (Ansevin, A.T., Vizard, D.L. *Biopolymers* 1976, 15, 153-174). Extension of the technique to the study of DNA· Drug complexes will be outlined.

A Technical Writing Course for Chemistry and Physics Majors, J.M. Bonicamp, Middle Tennessee State University.

The one-hour course in technical writing is designed to help advanced undergraduate chemistry and physics students develop the writing skills necessary to transmit technical information effectively, construct persuasive proposals, and produce clearly written reports of laboratory results. Students use writing exercises to improve their communication skills.

Pattern Recognition Applied to Methanol and Fusel Oil Content of Various Whiskeys, L. Wilson, A.E. Woods, Middle Tennessee State University, J.H. Ding, Changchun, Jilin, China.

Gas chromatographic data for methanol and fusel oils

in various whiskey samples has been subjected to a computerized pattern recognition program called Einsight. Using this data, the program was able to classify the whiskey samples into three groups.

Using Nuclide Stability and Decay Rules in General Chemistry, H.F. Blanck, Austin Peay State University.

General chemistry textbooks usually have a chapter on nuclear chemistry containing a graph of stable nuclides and a graph showing at least one of the three naturally occurring decay series. Of the textbooks examined none present sufficiently detailed empirical decay rules capable of predicting these decay routes and none present rules relating the stable nuclides to the atomic mass. An A,Z graph of all nuclides reveals patterns which may be translated into fairly accurate rules for stability and decay. For example with a few exceptions, for elements with an odd $Z \geq 9$ there are one or two stable isotopes for each element and each has an odd A value. To determine the A values round the molar mass to the nearest whole number going up if the decimal fraction is 0.45 or more. If the result is even then there are two stable isotopes having A values immediately above and below the even number. Other rules may be formulated that bring a bit of order out of chaos.

ENGINEERING SECTION
John T. Mason, *presiding*

Chemical Fire Retardant Permanency Studies, N. Chiou and D.W. Yarbrough, Tennessee Technological University.

Fire retardant chemicals are added to cellulosic insulations to reduce flammability. These insulations are commonly installed in residential attics and expected to retain the fire retardants over the lifetime of the structures. Mass transfer of fire retardants from the solid to the vapor phase has been suggested as an important factor in regard to permanency of fire resistance. The equilibrium vapor concentrations of boric acid and sodium borate, which are two of the most common fire retardants, have been determined by a transpiration method at the temperature of 363 K as a function of relative humidity. These data show that much of the published concern about fire retardant permanency has been based on data obtained by steam distillation. The data obtained in this study suggest very low mass transfer rates. The new vapor concentration data permit estimation of the time to lose sufficient chemicals to cause treated insulation to fail combustion tests.

Department of Energy Engineering Education Programs, A. Wohlpart, Oak Ridge Associated Universities.

Federal research and development laboratories in-volve undergraduate and graduate students, faculty members, and postgraduates in ongoing research activities. Additionally, these laboratories have extensive unique facilities which can be used by the academic community if the research complements ongoing programs. Research Participation Opportunities in science, engineering, and mathematics at select U.S. Department of Energy, U.S. Department of Health and Human Services, and Department of Defense laboratories will be described.

Dissolved Air Floatation: Operational Performance, C.R. Henderson, CSX Transportation, White House, TN.

The secondary industrial wastewater Treatment (WWT) system at the CSX WWT facility in Nashville, Tennessee, used for the processing and treatment of an oily emulsified wastewater is a 143–square foot dissolved air floatation (DAF) unit. Eighty four separate processing days were studied from November 1985 to 1986. Process parameters measured included water temperature, influent solids (O/G and SS), flow rates (GPM), and effluent solids (O/G and SS). The annual average value for temperature was 29.3 degrees C, and influent solids of 1702 MG/L (O/G = 731.3, SS = 970.7) and the effluent solids was 99.45 MG/L (O/G = 36.2, SS = 63.25). The annual process rate averaged 58.5 GPM. Performance data was then calculated based upon the measured operational data which resulted in a DAF performance for hydraulic loading of 0.409 GPM/FT2 and a solids loading of 0.348 LB/HR/FT2. The percent solids (O/G and SS) removal efficiency averaged 0.942 with an air to solids ratio (A/S) of 0.029 lbs air/lbs solids.

Transient Overvoltages On Overhead Lines Caused By Indirect Lightning Strokes, P. Chowdhuri, Tennessee Technological University.

Transient high voltages caused by lightning are considered to be one of the chief sources of disturbance to overhead lines. Such transient voltages can appear on an overhead line either by direct hit (direct stroke or by induction from a nearby lightning strike (indirect stroke). Because of the complex interaction among the various line and lightning parameters, predicting the worst possible severity of indirect strokes on an overhead line is difficult. The effects of some of these parameters are discussed. The parametric study shows that the magnitude of the induced voltages is directly proportional to the height of the overhead line above ground; the highest induced voltages on an overhead line may not appear at the point directly opposite the strike; and the current waveshape and the velocity of the propagation of the return stroke may significantly affect the severity of the induced voltage.

A Methodology For the Sizing Of Stand-Alone Photovoltaic Systems, G. Lewis, Memphis State University.

There is no doubt about the technical viability of photovoltaics as an electrical power source. Indeed, the spectrum of applications of photovoltaics is impressive—navigation guides, remote community integrated power supply, radio stations, grain mills, etc. From an engineering viewpoint, perhaps the most pertinent question is one regarding the methodology of sizing of a stand-alone photovoltaic system (SAPVS) in terms of the gross area of the photovoltaic array and the nominal capacity of the storage batteries, for a given load demand. The literature on this topic is sparse compared to that on the sizing of solar thermal systems. The few published works in the area of sizing of SAPVS are either simplistic (for example, the work of Buresch (*Photovoltaic Energy Systems: Design and Installation,* McGraw-Hill, NY, 1983) and Pulfrey (*Photovoltaic Power Generation,* Van Nostrand Rheinhold, NY, 1978), or too complex, having the disadvantage of being derived from and dependent upon simulation models that are quite lengthy (An analytical method to determine the optimal size of a photovoltaic plant, *Solar Energy* 33[6], 509–514, 1984). The present work fills an analytical void in that a methodology is presented which is easy to use without being naive. Details of the methodology, called the energy balance approach, are presented, and its working is illustrated with the use of two examples of SAPVS designs in the TVA area: a medium-scale agricultural produce cold storage system in Madison, AL, and a railroad crossing signal system in Memphis, TN. Results obtained using the present methodology are compared with those from other methods in the literature, leading to a critical appreciation of the present contribution.

Heat Transfer Through An Assembly of Spheres, M.H. Yang and D.W. Yarbrough, Tennessee Technological University.

A computational model for predicting the apparent thermal conductivity (k_a) of spheres or mixtures of two sizes of spheres has been developed and validated using experimental data for ThO_2 and a mixture of UO_2 and ThO_2. This model describes k_a in the temperature range 300 to 1300 K and pressures from 0.01 to 10 atm. For single spheres, the calculated k_a for small particles (44 μ m) are more sensitive to the value of the gas-solid accommodation coefficient (a) than are those for large particles (440 μ m) because of reduced void space and, hence, greater limitation of the gas molecule mean free path. For small spheres (44 μ m) in He, calculated values with a = 0.2 agree with experimental data to within 10%. The two-sphere version of the program predicts the k_a for UO_2-ThO_2 spheres to within 15% with a = 1. This program can be used to predict k_a as a function of temperature and pressure for a variety of particulate systems.

NCAS: NAVSTAR-Based Collision Avoidance System, S.P. Dev, Tennessee State University.

The Navstar Global Positioning System (GPS) uses 24 earth-satellites, most of them already aloft, to provide precise global navigation. It provides information about latitudinal and longitudinal location, altitude and velocity-vector to aircraft equipped with appropriate receivers. VCR-sized receivers now available cost a few thousand dollars; pocket-sized receivers to cost a few hundred dollars are being developed. Under the Navstar-based Collision Avoidance System hereby proposed, aircraft with GPS would emit, in short four-microsecond bursts at 2-GHz carrier frequency, the Navstar-derived information on location and velocity, and re-emit refreshed information every one-tenth of a second. The aircraft would also have a special receiver tuned to the universal 2-GHz NCAS frequency in the UHF band. An on-board microcomputer would process all received signals and convert them to traffic information on a Horizontal Situation Display in the cockpit. An Auto-Squelch-Control would avoid interference by processing only the closest aircraft. Thus, NCAS would provide a continuous display of nearby aircraft, independent of terrain or weather. NCAS would offer global collision-avoidance at modest cost, convert the Air Traffic Controllers from baby-sitters to system-managers/overseers and enhance aviation safety.

Comparison of the PRESTO-II and DRASTIC Methodologies for LLW Site-Selection, D.E. Fields and M.G. Yalcintas, Oak Ridge National Laboratory; I. Uslu, Turkish Atomic Energy Authority.

The object of this study is to compare the simulation results of PRESTO-II (Prediction of Radiation Effects from Shallow Trench Operations) with the DRASTIC system, and to test the validity and applicability of the DRASTIC system to find appropriate areas considering ground water pollution potential from low-level radioactive waste disposal sites. Choosing a waste disposal site from a set of candidate sites requires an approach capable of objectively handling many environmental variables for each site. Several computer codes have been developed to assist in the process of choosing a site for the disposal of low-level radioactive waste; however, most of these codes are costly to apply, both in terms of computer time, and in the time and effort required by professional modelers, geologists, and waste disposal experts. We describe how the relatively simple DRASTIC methodology may be used for "pre-screening" of sites to determine which subset of candidate sites is worthy of more detailed evaluation. Results of site comparisons made with DRASTIC

are compared with results obrtained using the PRESTO-II methodology, which is representative of the more complex release/ transport/human exposure methodologies. PRESTO-II is a computer code designed to evaluate possible doses and risks from shallow-land and, waste-disposal trenches. Our thesis is that if comparative results can be obtained with the two quite different, methodologies, then a significant cost saving can be had by "pre-screening" sites with the simpler methodology. Research sponsored by the Office of Health and Environmental Research, U.S. Department of Energy, under contract DE-ACO5-840R21400 with Martin Marietta Energy Systems, Inc.

Neural Networks: Possible Applications to Robotic Control, B.R. Copeland, Tennessee Technological University.

A basic neural network consists of an array of elements generally called "neurons," interconnections between the neurons, an I/O scheme and a learning rule. The knowledge imbedded in a neural network is contained in the interconnections. Neural networks exhibit several important properties: association, generalization, differentiation, preferential learning, optimization and fault tolerance. There are several possible applications to robotic control: environmental mapping, feature detection and object recognition, mapping from visual input to kinesthetic output (i.e. trajectory control); and using known object characteristics to determine the correct manipulator positions and forces. Some of the characteristics of neural networks lend themselves particularly well to the problems of unknown environments and robot degradation, particularly the learning and fault tolerance features. There are several drawbacks to the use of neural networks: to create effective networks, large numbers of neurons and much larger numbers of interconnections are necessary. Parallel hardware is not available or is extremely expensive. When implemented on serial machines they are very slow. The techniques for the design of neural computers are not extensively developed.

Solid Waste Landfill Data in Tennessee, J.T. Mason, Tennessee Technological University.

A review of data available in the Tennessee Department of Health and Environment revealed that some hazardous materials may be contained in solid waste landfills in Middle Tennessee. The extent of contamination could not be determined and more study to include selective environmental monitoring is needed to evaluate the scope of the problem.

GEOLOGY-GEOGRAPHY SECTION
Armin L. Clark, *presiding*

The Radiation Damage Line in ESR Spectra of Dolomite, D.N. Lumsden and R.V. Lloyd, Memphis State University.

Electron Spin Resonance (ESR) spectra of dolomite have a complex "peak" at $g = 2.0023$ that is due to radiation damage. The size of this peak increases with time as a function of the amount of radionuclides in the dolomite (U, Th, K), and exposure to cosmic rays. The peak is decreased by annealing effects, primarily temperature related. Laboratory annealing experiments and a study of an intruded dolomite at Marble Canyon, Texas suggests that the peak decreases to a constant size for a particular temperature and does not simply decrease exponentially to a near-zero value. The signal has potential in studies of: the temperature to which the dolomite was subjected after formation (paleothermometry), the time since the last thermal resetting of the center peak (absolute chronology), and the presence of organic free radicals and CO_3.

Comparison of Runoff Patterns of Selected Tennessee Watersheds, Hsiang-te Kung and M.E. Knack, Memphis State University.

This paper applies the Thornthwaite water budget method to three selected rural Tennessee watersheds. The calculated runoff from the three watersheds, using Thornthwaite water budget methods, are compared with the measured runoff data to evaluate the validity of the water budget method and to determine the possible effects of watershed characteristics on total amount of surface runoff. The average monthly calculated runoff for the East Fork of Stone River for the 14-year period, 1972–1985, was very close to the average monthly measured runoff. The Little River in East Tennessee produced more runoff than calculated, while the Loosahatchie River in West Tennessee produced less runoff. The discrepancy for the Little River is due to the fact that the watershed lies in an area of greatly variable elevation and precipitation. Water budget procedure does provide a useful means for understanding the basin hydrology in this study.

Effects of Recent Volcanism Along Kilauea's East Rift Zone, A.L. Clark, Murray State University.

The most recent volcanic activity along Kilauea's East Rift Zone began in January 1983, and built an 850 feet high cone called Pu'u O'o. In July 1986, the activity shifted to a new site, where a new cone is being built. The first lava flow reached the ocean at Kalapana in November 1986, and more have followed in 1987. Lava flows have

destroyed more than 30 homes at Kalapana and have added nearly 20 acres of land to the Big Island.

Gully Sedimentation and Incision in West Tennessee, M.L. Barnhardt, Memphis State University.

Most gullies in Meeman-Shelby State Park, Tennessee are actively incising their channels even though the area was intensively reclaimed by the CCC during 1935–36. Since 1900, over one meter of laminated silt and fine sand has been deposited on gully bottoms, burying modern cultural materials. This period of rapid sedimentation has been followed in many areas by incision exceeding two meters, exposing these cultural materials along gully walls. Upper gully segments are still dominated by depositional processes while downstream segments are experiencing primarily incision into their presettlement floodplains. Middle segments show the greatest transition from deposition to erosion over the last 90 years. The eroded sediment is moving downstream in eposodic pulses that can be traced using stratigraphic and pedologic markers. Historical sedimentation rates are 20 times greater than presettlement rates based upon radiocarbon and cultural dates.

January and July Temperature Trends in Tennessee, G. J. McCabe, Jr., Memphis State University.

Recent studies suggest that during the last 30 to 40 years winter temperatures in the southern United States have decreased, while summer temperatures have slightly increased. This study analyzes mean monthly January and July temperatures to identify winter and summer temperature trends for Tennessee. The examination of mean monthly January temperatures strongly suggests that in Tennessee winter temperatures have decreased in general since the early 1950's. Analysis of mean monthly July temperatures indicates a slight decline during the 1960's and early 1970's, but an increase of July temperatures since the mid 1970's.

Museums and Geological Education in Tennessee, J.X. Corgan, Austin Peay State University.

In the years since World War II, five Tennessee museums have emerged as major centers for child-oriented and adult-oriented education in the geological sciences. They are the Pink Palace in Memphis, the Mississippi River Museum in Memphis, the Cumberland Museum in Nashville; the Tennessee State Museum in Nashville, and the American Museum of Science and Energy in Oak Ridge. Each stresses different aspects of geology and has a distinctive program that serves thousands of visitors each year. Major aspects of each institution's role in geological education have been described in the scholarly literature. Programs are compared to each other and to geological

education offerings in museums in other parts of the world.

Modern Carbonate Sedimentation and Seawater Chemistry Studies, San Salvador, Bahamas, R.E. Bergenback and R. G. Litchford, The University of Tennessee at Chattanooga.

During spring break, 1983–1986 (6 days each year), the UTC Geosciences and Environmental Studies Department visited San Salvador Island, Bahamas and trenched beach sediments at four sites. They also mapped lagoon floors in Rice Bay (a lagoon on the northeast side of San Salvador) as well as off Sand Dollar Beach and in Bonefish Bay (shallow lagoons on the western, or leeward, side of the island). Avenues of carbonate sedimentation, stalked algae fields, coral reefs and sea grass patches were items mapped on lagoon floors. Numerous samples of sea water in leeward lagoons (off Sand Dollar Beach and in Bonefish Bay) were analyzed for a number of chemical parameters.

MATHEMATICS AND COMPUTER SCIENCE
Frederica Cornett, presiding.

Demonstration of a Prototype Wireless Computer Network for Tennessee Schools and Colleges, D.E. Fields, ORNL, and H. Miller, Ashville County Day School.

The exchange of electronic mail and computer files using telephone lines is a widespread but often expensive practice. Packet radio is a recent innovation in communications technology which permits the exchange to take place without incurring long-distance charges, and which includes automatic correction of errors incurred in transmission. In such a communications system, the telephone and modem are replaced by a specialized radio modem known as a terminal node controller (TNC) and a radio transceiver. Each station, or node, can provide an automatic relay function. A network of these wireless computer stations would provide a valuable, reliable, cost-effective link between Tennessee schools and colleges. The system would also function as an emergency communications network in case of disaster and has considerable educational potential in its own right. The principles and advantages of such a system are discussed, and a prototype system will be demonstrated and operated during the conference. Oak Ridge National Laboratory is operated for the U.S. Department of Energy by Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-840R21400.

A Compiler for the Algorithmic Language PL, L. Scroggin and F. Cornett , East Tennessee State University.

PL is an algorithmic language described in *Theory of*

Computation, by Walter S. Brainerd and Lawrence H. Landweber. According to this text, PL is "computationally as powerful as any 'real' programming language" and "any function $f:W^r \rightarrow W^s$ which can be computed by a computer program can also be computed by a PL program." The purpose of this paper is to describe a compiler for PL, authored by a team consisting of ourselves, Sara Stoecklin and Mark Mathis. PL is a simple language, consisting of two statement types—three forms of assignment statements, and LOOP, END, and GO TO statements for sequencing. For implementation, we added INPUT, OUTPUT and STOP statements, and a comment statement for documentation. Our compiler is written in Turbo Pascal and consists of two phases. Phase 1 parses the source program, performing lexical and syntax analysis, producing tables for phase 2 and a listing with diagnostics. Phase 2 generates object code in BASIC. This compiler is to be used as a teaching tool in a graduate level Theory of Computation class at ETSU.

Measures of Voting Power, V.R.R. Uppuluri, Y-12 Plant, and D.E. Fields, Oak Ridge National Laboratory.

In a weighted voting scheme we have n voters with weights $(w_1, w_2, .., w_n)$. Each voter may vote with yes or nay on a bill. A bill will be passed with a quota q, whenever the sum of the weights of the voteers who vote with a yes is at least q. For this scheme $[q: w_1, w_2, .., w_n]$ we discuss the voting power of the candidates. We will review the properties of two measures of voting power proposed by Shapley-Shubik and Banzhaf.

Validation of the RAGTIME87 Dynamic Food-chain Model Against Fallout Data from the Chernobyl Accident, G.G, Killough*, Omegafont Communications, and F.O. Hoffman**, Oak Ridge National Laboratory.

RAGTIME87 is a recently developed dynamic model that simulates components of an agricultural system (deposition and retention of airborne pollutants on grain crops and pasture grass, and transmission of the pollutants to milk and beef). In the case of radioactive pollutants, some of the parameters in such models have been based on fallout data from weapons testing in the 1950s and 1960s, but there have been few opportunities for validating the models against independent data. After the release of radioactivity from the Chernobyl nuclear reactor accident, monitoring at many sites throughout the world has provided time-series data for atmospheric concentrations of radionuclides (primarily iodine-131 and cesium-137), rainfall, and concentrations of radioactivity on grain, on pasture grass, and in milk and beef from animals that fed on the contaminated grain and pasture grass. The models

accept the atmospheric concentrations and rainfall data and predict time series for the other variables, which can then be compared with their measured counterparts. Along with 20 other models, RAGTIME87 has participated in an international exercise for testing the predictions of biospheic transport models (BIOMOVS) that has been initiated by the Swedish National Institute for Radiation Protection. The data accumulated for model testing are based on the monitoring of Chernobyl fallout data at 13 sites around the world. Structural details of RAGTIME87 and selected results of the intercomparison are discussed. *Participation supported by Omegafont Communications of Oak Ridge, Tennessee. **Research sponsored by the Office of Health and Environmental Research, U.S. Department of Energy, under Contract No.DE-AC05-840R21400 with Martin Marietta Energy Systems, Inc.

The Use of Expert Systems on Personal Computers to Provide Aid for the Non-Expert User, L. Scroggin, East Tennessee State University.

Expert Systems are being developed at East Tennessee State University for use in a personal computer laboratory. These expert systems will facilitate the use of the computers, printers and the software available in the computer laboratory. The purpose of these expert systems is to make expert advice available at any time. This is accomplished by providing solutions to common problems and the answers to often asked questions. The software package Personal Consultant Plus is the expert system development tool from Texas Instruments which is being used to produce the expert systems. Personal Consultant Plus, which runs on IBM XT's and XT compatible computers, allows for the quick development and easy maintenance of the expert systems. Because of the maintainability of these expert systems, as new problems or questions are identified these systems can be easily updated. It is hoped that these expert systems will provide the assistance that is needed by new PC users.

Research Opportunities at Federal R&D Facilities, A. Wohlpart, Oak Ridge Associated Universities.

Research opportunities, internship appointments, and graduate student and post graduate student fellowship programs are described. Research and internship appointments for undergraduate and graduate students, primarily at U.S. Department of Energy laboratories, are available throughout the year. Various programs of support for graduate study at universities and postgraduate research at select U.S. Department of Energy, U.S. Department of Health and Human Services, and Department of Defense laboratories are discussed.

MEDICAL SCIENCES SECTION
R. Dean Blevins, *presiding*.

Distribution and Pathogenicity of Acanthamoeba castellanii, T. Bondurant and G. Tomlinson, Tennessee State University.

The cyst-forming capability of these soil amoebae has enabled them to spread via air, soil, water, food and contaminated objects from the frigid soil of antarctica to the tropical waters of the pacific; from "washed" vegetables of Mexico to treated and bottled mineral water in Germany; from the filtered air of Australia to the dental treatment rinsing units of South America; from hot tubs of the USA to the cold soils of Poland; from contact lenses in America to *Legionella* cultures of Israel and England. *Acanthamoebae* are opportunistic pathogens in mice, dogs and humans associated with meningoencephalitis, brain tumors, keratitis of the eye, meningitis, amebic dysentery, osteomyelitis, lung infections, cerebral and cerebellar abscesses, pneumonia, Viluy encephalomyelitis, and most recently as killers of weakened AIDS patients. *Acanthamoebae* are very resistant to antibiotics, antimetabolites and typical cytostatic agents. More specifically, they are resistant to greater than 1000 ug/ml levels of paromomycin, polymysin, B-bacitracin-neomyucin, acriflavine, 5-fluorocytosine, amphotericin B, gentamicin, and trimethoprim-sulfamethoxazole. Thus, effective control procedures are not yet available to control this opportunistic pathogen in debilitated hosts.

An Evaluation of Environmental Concerns at the Oak Ridge Sewage Sludge Land Treatment Facility, A.F. Iglar, East Tennessee State University.

Digested sludge from the city of Oak Ridge Sewage Treatment Plant was applied to surface soil in the federal government's Oak Ridge Reservation. Study indicated that, at times, the sludge contained significant levels of cobalt-60 and cesium-137, as well as substantial concentrations of heavy metals and nitrogen. Although application rates were excessive and cumulative application of several heavy metals had exceeded limits, little evidence could be found of migration of hazardous contaminants from the site. Recommendations for the facility included establishment of quality standards for sludge to be disposed of, and implementation of a management plan that would assure satisfactory operation. The original site now has been closed, and another location used with appropriate controls.

Mutagenicity of the Active Ingredient in Birth Control Pills, S.V. Char and R.D. Blevins, East Tennessee State University.

The object of this study was to determine the mutagenicity of the active ingredients in birth control pills. A set of five compounds, three progesterons and two estrogens, were tested for their ability to cause mutation. The system used to test for mutagenicity was the Ames *Salmonella typhimurium* Microsomal Assay. The pure preparations of the compounds used were norethindrone, norethindrone acetate, and D(–)norgestrel (2.5 µg/plate to 10 µg/plate) and the estrogens ethynyl estradiol and ethynyl estradiol 3 methyl ether (1.25 µg/plate to 5 µg/plate). The results obtained thus far show mutagenicity for norethindrone with strain TA97, which would indicate, a frame shift type of mutation. Ethynyl estradiol, ethynyl estradiol 3-methyl ether and D(–)norgestrel produced a toxic response to all Salmonella tester strains at much lower concentrations (3.75 µg/plate and above for ethynl estradiol and ethynyl estradiol 3-methyl ether and 7.5 µg per/plate and above for D(–) noregestrel) than that present in the pill (0.05 mg/pill for the former two chemicals and 1 mg/pill for the latter chemical. A pill containing norethindrone (1 mg/pill) and mestranol (ethynyl estradiol at 0.05 mg/pill) was also tested at concentrations of 12.5 µg/plate to 50 µg/plate for norethindrone and 0.625 µg/plate to 2.5 µg/plate mestranol and was found to be highly mutagenic to strain TA97. These two compounds are the most commonly used combination in most birth control pills.

The Effects of Acute and Chronic Toxicity of Parathion on Nucleic Acids, Proteins, and Glycogen in the ICR Swiss Albino Mice Internal Organs, K.W. Rigsby and A.C. Wells, Tennessee State University.

This study conducted on the effects of acute and chronic toxicity of parathion on nucleic acids, proteins, and glycogen in the ICR Swiss Albino Mice Internal Organs has been carried out. All of the mice involved in this study were subjected to the same trauma which included saline and parathiøn. The time frame for each individual mouse was administered at 30 minute intervals. The purpose of the time frame was to look for pharmacodynamics and to see if parathion was distributed to all parts of the body. The mice were injected intraperitoneally with a volume of .01 ml/g body weight and subcutaneously with a volume of .005 ml/g body weight. The results obtained in this investigation shows that 10 mg of parathion can cause a significant change in the levels of DNA, RNA, proteins, and glycogen in the following internal organs: liver, heart, spleen, testes, kidneys, and muscle respectively to a P value less than .01 when compared to the control. It is evident that the effect of parathion was highly significant on the levels of DNA, RNA, proteins, and glycogen in the internal organs above under the conditions in which this investigation have been conducted.

Substance P and Calcium Inophore AZ3187 Induced Release of Histamine from Mouse Mast Cells, S. Khandkar, M.W. Hougland, and A.E. Hougland, East Tennessee State University.

[EDITOR'S NOTE: No abstract received before press time.]

An Evaluation of Microwave Irradiation as a Method of Sterilizing Materials Commonly Used in Patient Care, D. Matikke and C.S. Bishop, East Tennessee State University.

The purpose of this study was to evaluate the practice of using microwave irradiation as a method of sterilizing dry surfaces of materials commonly used in patient care. The indicator organisms used were *Staphylococcus aureus* and *Pseudomonas aeruginosa.* Four test surfaces (plastic, glass, gauze and terrycloth) were used. After contaminating the test surfaces, they were dried in an oven and irradiated with microwaves for 120 seconds. The microwave radiation source was a conventional microwave oven (2450 MHz). Recovery was attempted using the swab method for plastic and glass surfaces and the blender method for the gauze and terrycloth. Microwave irradiation did not sterilize any of the tested surfaces. There was an average seventy-four percent and eighty-one percent survival rate for *Staphyloccocus aureus* and *Pseudomonas aeruginosa,* respectively.

A Preliminary Analysis of Aeromedical Service in Memphis, J.A. Johnson and W.J. Jones, Memphis State University.

In 1986 a consortium of four major hospitals in Memphis, Tennessee began providing air ambulance services for the Mid-South region. This preliminary study seeks to analyze significant variables involving service delivery and patient care provided by this interorganizational system. Among the variables included in the analysis were the demographic mix of patient cases, types of emergency situations, geographic distribution of cases, response patterns, incident/safety records, and service costs. Our preliminary findings illustrate a number of significant patterns which have implications for the effective provision of aeromedical services by the Memphis consortium and similar systems around the country. These findings and implications are discussed in this paper and are the subject of ongoing investigation.

Effect of Carbaryl on Growth of Tetrahymena pyriformis, R.J. McFarland and A.C. Wells, Tennessee State University.

Organic pesticides are an example of the many chemicals which have helped man in the quest for the improvement of his environment. Much concern is being expressed over the decreased usage of persistent insecticides, this leading to the usage of alternatives such as the carbamate anticholinesterase that is widely used in agriculture in the control of insect vectors of disease and to control household and garden insects. Carbaryl has been widely used all over the world to a greater extent than all the other carbamate insecticides combined. Carbaryl (1-napthyl-N-methyl carbamate) on growth of *Tetrahymena pyriformis* was investigated. This species is widely used on pharmacological and biochemical studies. Carbaryl may sometimes be used as a DDT substitute to reduce environmental pollution since it is biodegradable. The effect of DDT on cell population growth of *Tetrahymena pyriformis* was found to inhibit cell population growth at concentrations of 50 and 100 ppm. This present investigation was undertaken to determine how Carbaryl would affect cell population growth of *Tetrahymena.* The concentrations used in this investigation were 100 µg, 200 µg, 400 µg, and 500 µg/ml, respectively. The cells were inoculated after 24 hours of growth with the above concentrations. Under the conditions in which the organism was investigated, 100 µg and 200 µg/ml. respectively did not completely inhibit cell population growth, while 400 µg and 500 µg/ml. respectively inhibited cell population growth significantly as determined by a P value less than 0.01. Further studies are being undertaken to determine the effects of Carbaryl on cellular organelles in *Tetrahymena.*

Fertilizability of Murine Oocytes Aged in vivo and in vitro, B.S. Minhas et al., Quillen-Dishner College of Medicine, East Tennessee State University.

[EDITOR'S NOTE: No abstract received before press time.]

The Quality of Bottled Water Sold on the Commercial Market in Johnson City, Tennessee, M.A. Kelty, P.R. Scheuerman, C.S. Bishop, R.D. Blevins, East Tennessee State University.

Previously published literature has shown the quality of some commercially bottled water to be questionable. In this study, ten brands of bottled water were purchased from local grocery stores and tested (using Standard Method procedures) for most of the parameters which are Federally regulated (microbiological quality—including coliforms, turbidity, color, arsenic, barium, cadmium, chloride, chromium, copper, iron, lead, manganese, selenium, silver, sulfates, total dissolved solids, zinc, and fluoride). A taste test was also conducted utilizing 21 subjects who ranked the water samples on a one (poor taste) to five (excellent) scale. Mutagenic properties of the water samples were tested using the Ames *Salmonella/ mammalian* microsomal mutagenicity assay. Salmonella strains used were TA97, 98, 100, 102 and 1535, with the test being done both with and without the enzyme activa-

tion system S9. None of the measured parameters exceeded the Food and Drug Administration maximum allowable concentrations. Eight of the water samples in the taste test were rated fair (two on the scale), and two water samples were rated poor (one on the scale). The mutagenicity tests did not show a dose response, a requirement for mutagenicity; however, there was a 2× increase in the number of produced revertants over that of spontaneous revertants for some tested dosages.

The Effect of Pancreatic Enzyme Supplementation upon Growth Rate, Feed Efficiency, and Carcass Characteristics of Growing-Finishing Swine, R. Carbaugh, R. O'Bannon, and T. Phillips, Lee College.

Fifteen weanling pigs randomly assigned to one of three treatment groups were fed a common corn-soybean ration for about 14 weeks. Group I (ENZ) was continuously supplemented with 250 gm. of pancreatic enzymes/100 lb. of feed; Group II (ALT) was supplemented with this amount one week, alternating with no enzymes the next; and Group III (CON) served as control with no enzymes throughout. Weight gains and feed efficiency were determined weekly. Carcasses of three slaughtered animals from each group were examined. Average daily weight gains for the ENZ, ALT and CON groups were 1.58, 1.70 and 1.56 lb. respectively. Feed required/lb. of gain was 4.03, 3.86 and 3.90 lb. respectively. Average carcass length for the ENZ, ALT and CON groups was 31.0, 30.1 and 30.3 in. respectively. Average backfat thickness determined by measurements at the first rib, last rib and last lumbar vertebrae was 1.18, 1.29 and 1.61 in. respectively. Average loin eyes were 4.07, 4.90 and 4.40 in.^{2} for the three groups respectively.

The Effect of Pancreatic Enzyme Supplementation upon Blood, Pancreas and Fecal Analyses of Growing-Finishing Swine, R. O'Bannon, R. Carbaugh, and T. Phillips, Lee College.

Fifteen weanling pigs randomly assigned to one of three treatment groups were fed a common corn-soybean ration for about 14 weeks. Group I (ENZ) was continuously supplemented with 250 gm. pancreatic enzymes/100 lb. feed while Group III (CON) received no enzymes. In Group II (ALT), the enzymes were added every other week. Analysis of blood drawn at the conclusion of the experiment showed little differeence in RBC counts, hemoglobins, hematocrits or platelet counts. WBC counts for the ENZ, ALT and CON groups were 23.2, 18.6 and 17.3 × 10^3 respectively. White cell differentials showed more variation within groups than between them. Serum cholesterols and triglycerides were 119 and 56, 123 and 70, and 112 and 59 mg/DL for the ENZ, ALT and CON groups respectively. Within group variation of amylase

and lipase activities in serum, feces and pancreatic homogenates exceeded that between groups. Average pancreas weights of the three pigs slaughtered from each group were 97.7, 90.1 and 82.5 gm. for the ENZ, ALT and CON groups respectively.

PHYSICS AND ASTRONOMY SECTION
John P. Wikswo, Jr., *presiding.*

Vanderbilt University Free-Electron Laser Center for Biomedical and Materials Research, G. Edwards, Vanderbilt University.

A Free-Electron Laser (FEL) facility is currently under construction on the campus of Vanderbilt University. The FEL is designed to provide pulsed radiation in the wavelength range of 0.25 to 10 microns. Design specifications call for an energy per pulse (60 Hz operation) of up to 550 millijoules (2–4 microns), 300 millijoules (1–2 and 4–10 microns), and 75 millijoules (0.5 to 1.0 microns). The pulse widths are on the order of picoseconds. Lasing is anticipated in approximately two years. In addition to the construction of the FEL instrument, the contract supports five research programs in the Departments of Physics, Molecular Biology, Otolaryngology, and Neurosurgery. Of particular interest to the Tennessee Scientific community, the center will be a local, regional and national resource for visiting scientists. Supported by ONR Contract N00014-87-C-0146.

Effect of the Burnett Correction on Numerical Simulations of Diffusion, J.W. Hanneken and P.C. Shipe, Memphis State University.

The Burnett correction term to the one-dimensional diffusion equation and a hopping model which gives a physical interpretation of the Burnett term were derived. The resulting equation is $\delta C/\delta T = \delta^2 C/\delta X^2 + \beta \delta^4 C/\delta X^4$ where the dimensionless concentration C = c/c$_0$ time T = D$_2$ t/L^2 and position X = x/L. The constant $\beta = D_4/(D_2 L^2)$ where D$_2$ is the standard diffusion coefficient, D$_4$ is the Burnett coefficient and L is the sample length. This differential equation was solved numerically utilizing B-splines and the Rayleigh-Ritz Galerkin method of solving partial differential equations. Numerical simulations were obtained for $|\beta|$ ranging from 0.00001 to 10. These simulations were used to estimate the smallest $|\beta|$ values which could be determined from concentration measurements with a given experimental uncertainty.

The German Experience with the Chernobyl Accident, I. Winkelmann, Institut für Strahlenhygiene des Bundesgesundheitsamtes, Neuherberg, Federal Republic of Germany, and D.E. Fields, Oak Ridge National Laboratory.

Results of radioactivity measurements in the Federal

Republic of Germany after the reactor accident in Chernobyl are presented. A few days after the accident the radioactive plume passed the southeastern part of the territory of the Federal Republic of Germany on April 30, 1986. The results of the measuring program for the determination of the activity concentration of radionuclides in air are given. This program included gamma measurements of particulate and iodine filter samples as well as radiochemical analyses for the determination of strontium isotopes and alpha emitting nuclides. Furthermore, measurements of the activity distribution of particulates and autoradiography on aerosol filter samples were carried out. An intensive program on soil contamination measurements using both *in situ* gamma ray spectrometry and soil samples covered the territory of the Federal Republic of Germany. The results gave evidence that the soil contamination reached the highest values in the south and decreased significantly towards the north and the west of the Federal Republic of Germany. The foodstuff measuring program led to a comprehensive survey of the development of the contamination of fruit, vegetables, grains, milk and milk products, animal products and mushrooms. The results are compared to whole body counting measurements. The recommendations given by the German Radiation Protection Committee are described. Based on the collected data, the German Radiation Protection Committee has made an estimate of the radiation exposure to the public for the first year after the Chernobyl accident. For the Munich area the effective dose equivalent is 0.3–0.9 mSv for children and 0.2–0.5 mSv for adults.

A Photometric Study of the Triple System V772 HER, James Bruton and Douglas S. Hall, Dyer Observatory, Vanderbilt University.

V772 Her = HD 165590 is a spectroscopic-visual triple system comprised of two G dwarfs and an M dwarf, one of which has a spotted surface. The G and M spectroscopic pair also eclipses partially. We analyzed photometric data in the U, B, and V bandpasses from R. Lines, the Automatic Photometric Telescope, and J. Bruton, and in V only from C.D. Scarfe. Fourier analysis of points on the light curve outside of eclipse shows a wave, due to starspots, of amplitude ~$0.^{m}02$. Its period is variable and close to the $0.^{d}88$ orbital period: $0.^{d}880$ in 1977, $0.^{d}872$ in 1984, $0.^{d}879$ in 1985 and early 1986, and $0.^{d}882$ in late 1986. Altogether, sixteen times of primary eclipse minima were analyzed, six previously published and ten new. After removing the light-travel-time effect due to the third star, a new linear ephemeris, JD(hel.) 2443665.45994 + $0.^{d}8795045$ E, satisfies the sixteen times within their errors. Three more times of conjunction were derived from Fourier analysis of residuals from the starspot wave

analysis, i.e. from the ellipticity effect. They also agree with the new ephemeris, within their errors.

Electric Properties of Cardiac Muscle—The Bidomain Model, B.J. Roth, Vanderbilt University.

Cardiac muscle is a multicellular tissue with extremely inhomogeneous properties at the microscopic or cellular level. One way to describe these electrical properties is to derive a macroscopic, homogeneous model that represents a space average of the microscopic inhomogeneities. This description is analogous to the macroscopic description of the polarizability of a dielectric, where the inhomogeneity of the microscopic atomic structure gives rise to a single macroscopic number, the dielectric constant. However, cardiac muscle is more complex than a dielectric for three reasons. First, the tissue is anisotropic because the cylindrically-shaped cells are aligned in parallel, so the electrical properties of the tissue are different, both in directions parrallel and perpendicular to their axis. Second, the tissue is multicellular, so the distribution of current in both the intracellular and interstitial space must be considered. Third, cardiac muscle is a syncytium, meaning that the intracellular spaces of all the cells are connected through intercellular channels at the gap junctions. To describe these properties, the bidomain model was developed. The term "bidomain" originates from the consideration of two domains, intracellular (i) and interstitial (o). At each point in the tissue two potentials, ϕ_i and ϕ_o, are defined for each domain. The two domains are not independent, but interact by passing current through the cell membrane, having impedance Z_m. The anisotropic electrical properties of the tissue are described by two conductivity tensors, $\tilde{\sigma}_i$ and $\tilde{\sigma}_o$. Using the continuity of current and Ohm's law, the pair of equations

$$\nabla \cdot (\tilde{\sigma}_i \cdot \nabla \phi_i) - \beta/Z_m(\phi_i - \phi_o) = 0$$
$$\nabla \cdot (\tilde{\sigma}_o \cdot \nabla \phi_o) - \beta/Z_m(\phi_i - \phi_o) = 0$$

govern the electrical potentials, where β is the surface-to-volume ration of the tissue. These equations can be solved analytically in several interesting cases and can always be solved numerically. They are useful for studying action potential propagation in cardiac tissue, for interpreting measurements of extracellular potentials such as the electrocardiogram, and for aiding in our understanding of cardiac defibrillation.

BAFFLE Your Physics Students, R.W. Clark, Middle Tennessee State University.

BAFFLE is an acronym for Background Audio For Further Lecture Enhancement. A brief BAFFLE lecture

on the electromagnetic spectrum illustrates the system, which utilizes a hidden source of audio at appropriate moments in the lecture.

Correlation Between Thorium Concentrations in Soil and Gamma Readings in FUSRAP Site in New Jersey, M.G. Yalcintas, and D.E. Fields, Oak Ridge National Laboratory and I. Uslu, Turkish Atomic Energy Agency.

Thorium ores were processed in Wayne and Maywood, New Jersey, between 1916 and 1956. During the course of Th processing, the wastes from the operations were pumped into dikes next to plant. Construction in the area caused the dispersal of waste into adjacent areas. The Department of Energy (DOE) adopted a policy of assigning an independent verification contractor to ensure the effectiveness of remedial action performed within the Formerly Utilized Sites Remedial Action Program (FUSRAP). The Environmental assessment group of Oak Ridge National Laboratory has been assigned the responsibility for this task at the Maywood and Wayne, New Jersey sites. During this effort, it is important to estimate the concentration of thorium in soil rapidly and accurately over large ares. One way to establish that task is to scan that area with a scintillation counter. The soil samples collected from the same area analyzed to determine the thorium concentration, which the analysis may be completed in three to four weeks. In this study, a correlation is described between the thorium concentration and the gamma readings of the site. The statistical analysis of the data indicates that this correlation is site-specific and depends on the depth of the radionuclide. Data will be presented, and the method of analysis will be described. Research supported by Health and Safety Research Division, ORNL, under DOE contract DE-AC05-840R21400.

On The Existence of a Group of "A"-Type Stars at $b^{II}=+9°$ $l^{II}=201°$, A.M. Heiser, Dyer Observatory, Vanderbilt University.

In the course of a class project involving the use of the Henry Draper (HD) catalog, which contains spectral type information from the early 1900's, we noted an unusually large number of stars classified as "A" in a region centered at galactic latitude (II) = +9° and galactic longitude (II) = 201°. "A" stars in the HD have been placed in this classification, rather than at B8, b9, A0, or A2, for at least two reasons. One, some of the stars in question have overlapping spectra on the original objective prism plates which make a more exact classification not possible, and second, some of the spectra are probably close to the plate limit in terms of faintness and again are difficult to classify. The number of "A" type stars found in regions of comparable size, on the sky, surrounding the region in question is three

to five times less. A further investigation of the spectral types of some of these "A"-type stars on objective prism plates obtained with the Schmidt telescope at the Warner and Swasey Observatory at Case–Western Reserve University indicates that these stars are most probably in the A0 to A2 range. Photometry is now underway at the Dyer Observatory in order to obtain magnitudes and color indices for the stars in this region to study the possible physical reality of this group.

Construction of a Six-Inch Reflecting Telescope, J.R. Bennett and J.R. Bennett, Vanderbilt University.

Using an amateur mirror-making kit and materials obtained from a hardware store, we have built a six-inch Newtonian telescope. In this talk, we explain the process of grinding out the mirror's curve from a flat Pyrex disk using silicon carabide abrasive and that of polishing the mirror with cerium oxide powder. We also discuss some design considerations in making the telescope's mounting, especially those of allowing for portability and for flexibility in aiming the telescope. Finally, we describe some simple optical properties of the telescope and their implications for its use.

Investigation on Nuclear Structure by Recoil Mass Spectrometer, X. Zhao, J.H. Hamilton, A.V. Ramayya, C. Maguire, Vanderbilt University, and T. Cormier, University of Rochester.

The recent development of a new generation of spectrometers, Recoil Mass Spectrometers, have opened up previously inaccessible areas of study such as nuclei quite far off the b stability line. These nuclei are expected to exhibit unusual phenomena such as super deformation, shape coexistence and shape transition, which are important concepts in understanding the nuclear structure. Combining the Recoil Mass Spectrometer with state-of-the-art detector systems, information on particular nuclei with very low production cross sections can be collected and analyzed without the interference from any other nuclear reaction products. Progress on probing nuclei in the mass 70 region will be reported including new examples of shape coexistence and new N = Z nuclei.

SQUID Magnetometry for Non-Destructive Testing, J.P. Wikswo, Jr., Vanderbilt University.

Superconducting QUantum Interference Device (SQUID) magnetometers are highly-sensitive detectors of magnetic fields and might be useful for non-destructive evaluation (NDE). A review of the few reports in the literature indicates that SQUIDs can be used to improve the sensitivity of eddy-current devices for NDE, to detect changes in the sign of the magnetoelastic coefficient as the

plastic limit is approached, and to measure the distortion in externally-applied electric and mangetic fields resulting from defects and fractures in ferromagnetic and other conducting materials. The same techniques developed for recording and analyzing magnetic fields from bioelectric currents in the heart and brain can be applied to these problems, as well as to the mapping of current distributions in two-dimensional microelectronic devices. We will discuss the factors governing the sensitivity of non-destructive evaluation with SQUIDS and a number of potential applications of the technique. Supported by Air Force Office of Scientific Research Grant AFOSR-87-0337.

Prediction of Radiation Effects From Proposed Low-Level Waste Disposal Sites in Turkey, I. Uslu, Turkish Atomic Energy Authority, D.E. Fields and M.G. Yalcintas, Oak Ridge National Laboratory.

PRESTO-II (Prediction of Radiation Exposures From Shallow Trench Operations) computer code is used to assess the risk associated with the shallow land disposal of low level radioactive waste (LLW) in various sites in Turkey. A preliminary simulation using the PRESTO-II computer code has been run for the site in Koteyli-Balikesir and Kozakli-Nevsehir. This example simulation was performed using the same radionuclide data set believed representative of the LLW disposal facility in Barnwell, South Carolina. These simulation results must be generally regarded as estimates based on the assumptions about waste stream composition, disposal methodology, and site geography. Lower consequences are predicted for the Barnwell, South Carolina site and Kozakli-Nevsehir, relative to the Koteyli-Balikesir but this conclusion results largely from the assumption that the Koteyli, Turkey site may eventually be used for farm land. If the Koteyli, Turkey site were not irrigated, predicted consequences for this site would be considerably lessened. Preliminary simulations have been performed of release and transport of radionuclides from a proposed low-level radioactive waste disposal site in Turkey. We expect that the results of these simulations will be useful in providing estimates of the consequences of alternative disposal sites and practices. Research sponsored by Office of Health and Environmental Research, U.S. Department of Energy, under contract DE-AC05-840R21400 with the Martin Marietta Systems, Inc.

The German Experience With the Chernobyl Accident, I. Winkelmann, Institute for Radiation Hygiene, Federal Republic of Germany.

Results of radioactivity measurements in the Federal Republic of Germany after the reactor accident in Chernobyl are presented. A few days after the accident the radioactive plume passed the southeastern part of the territory of the Federal Republic of Germany on April 30, 1986. The results of the measuring program for the determination of the activity concentration of radionuclides in air are given. This program included gamma mesurements of particulate and iodine filter samples as well as radio-chemical analyses for the determination of strontium isotopes and alpha emitting nuclides. Furthermore measurements of the activity distribution of particulates and autoradiography on aerosol filter samples were carried out. An intensive program on soil contamination measurements using both *in situ* gamma ray spectrometry and soil samples covered the territory of the Federal Republic of Germany. The results gave evidence that the soil contamination reached the highest values in the south and decreased significantly towards the north and the west of the Federal Republic of Germany. The foodstuff measuring program led to a comprehensive survey of the development of the contamination of fruit, vegetables, grains, milk and milk products, animal products and mushrooms. The results are compared to whole body counting measurements. the recommendations given by the German Radiation Protection Commitee are described. Based on the collected data, the German Radiation Protection Committee has made an estimate of the radiation exposure to the public for the first year after the Chernobyl accident. For the Munich area the effective dose equivalent is 0.3–0.9 mSv for children and 0.2–0.5 mSv for adults.

SCIENCE AND MATHEMATICS TEACHERS SECTION
Robert R. Marchini, *presiding.*

Aquaculture: An Alternative Curriculum Design, L.M. Buckley, Jackson State Community College.

An aquaculture curriculum is being planned at Jackson State Community College to diversify options for students of agriculture, biology, and related majors. Four courses totaling twelve semester hours comprise the curriculum which emphasizes experiential learning and problem solving. "Principles of Aquaculture"and the more technical "Water Quality Management" will each include a three-hour weekly laboratory. "Recent Advances in Aquaculture" will comprise field trips, seminars, and guest speakers. The program culminated with a one-semester internship opportunity. The pilot for the new curriculum was a continuing educaton class with unexpectedly high enrollment entitled "Southern Fish Farming". This course was the model for the lecture portion of the proposed "Principles of Aquaculture". Worksheets guided each student through the planning of a small-scale aquaculture system. The interdisciplinary nature, practical applications for self-improvement, and informal at-

mosphere attracted a diverse audience and will be characteristic of the entire curriculum.

The Academy's Evolving Archives, J.X. Corgan, Austin Peay State University.

Since it was established in 1912, the Tennessee Academy of Science has generated an impressive amount of manuscript material, chiefly minutes of meetings, form letters, and the correspondence of officers. For years from 1912 through February of 1940, the Tennessee State Library and Archives has an essentially complete archival collection. For years from 1971 through 1974, the Jean and Alexander Heard Library of Vanderbilt University has the secretary's files. For other years archives were not maintained. An effort is now being made to complete the archival record. This talk will identify all major donations made to the academy's archives during recent years. It will also provide a list of years for which programs and other memorabilia are unknown.

The Textbook Treatment of Thomson's e/m Experiment, M. Tidwell, Tennessee Technological University.

In 1897 J.J. Thomson performed the famous experiment in which he determined the charge to mass ratio of the electron. Some differences between Thomson's published description of that experiment and its usual textbook treatment are discussed.

Science Teachers Research Involvement—An Experiment in Teacher Development, W.L. Stevenson and Y.D. Sanders, Oak Ridge Associated Universities.

Responding to a national concern over science and mathematics education, the National Science Foundation provided funding to Oak Ridge Associated Universities for a pilot program called STRIVE, Science Teachers Research Involvement for Vital Education. During the first two years of the program's operation, nearly 40 Tennessee junior and senior high school teachers were appointed to positions on major, scientific research projects being carried out in government, industry, and university research laboratories. This paper reports on the accomplishments of this program and shows that, at least in the short-run, involvement in scientific research can have a significant impact on the knowledge, interest, confidence, and classroom activities of parrticipating teachers.

A Comparison of the Performance of RDS and Non-RDS Students in College Mathematics, D. Wynn and R.K. Fletcher, Jr., Tennessee Technological University.

This study compared former remedial students with non-remedial students in regular college mathematics courses. The two groups were compared on regular college mathematics grades, ACT composite scores, ACT mathematics scores, and high school grade point averages. Results from the analysis of variance indicated no statistically significant difference on regular college mathematics grades but highly significant differences on the other three predictor variables. Results from stepwise linear regression indicated that performance on RDS courses and tests were better predictors for RDS students while the ACT mathematics scores and high school grades were better for regular college students.

A Physics Program for Elementary Teachers, R.R. Marchini, Memphis State University.

The Memphis City School System has inaugurated a program to improve the teaching of science at all levels. Funds have been allocated for the training of elementary teachers in biology, chemistry, earth science and physics and for the construction of laboratories in each of the elementary schools. The makeup of the physics course for elementary teachers, the reaction of the teachers and the effect on the teaching of physics at the elementary level will be discussed.

ZOOLOGY SECTION I
David H. Kesler, *presiding.*

Effects of an Early Spring Snow Storm on Eastern Bluebird Nesting Activities, T.D. Pitts, The University of Tennessee at Martin.

The relatively mild winter of 1986–1987 in northwest Tennessee allowed Eastern Bluebirds (*Sialia sialis*) to begin nesting activities in mid-March. The mild weather was punctuated by a 10 cm snowfall during the day of 30 March. Bluebirds were stressed by reduced food intake and subfreezing temperatures for 24–36 hours. Some females had completed their first clutches prior to 30 March, other females had started but had not completed their clutches, and some females were preparing to begin egg laying. Responses to the adverse weather included: roosting in the nest cavity, skipping one or more days of egg laying, laying smaller than normal clutches, laying smaller than normal eggs, delaying clutch initiation, and delayed hatching. Most pairs suffered few long term effects; the major effect may have been a reduction in the number of offspring produced.

Plasticity in Length of Hindgut Segments of White-Tailed Deer, F.W. Weckerly, Memphis State University.

Plasticity in lengths of small intestines, caeca and large intestines was examined in free ranging adult white-tailed deer (*Odocoileus virginianus*) from Tennessee. Using cube root of body mass as a covariate, relative lengths of caeca and large intestines varied significantly among

seasons with segments being shortest in fall and longest in summer. The greatest single season increase for caeca (32%) and large intestines (25%) was from fall to winter. Lengths of hindgut segments of lactating and nonlactating females from summer were not statistically different. Analysis of intestinal segments during winter from three sites representing a gradient of good to poor forage quality (fiber content) also showed no statistical difference. Seasonal changes in lengths of intestines appear to reflect historical differences in food quantity and quality in fall and winter and increases in metabolism in spring and summer. The lack of variation in hindgut segments within a season suggests that intestinal length is under genetic control not evironmental induction.

Observations of the Gray Treefrog (Hyla versicolor) *During the Breeding Season in Western Tennessee,* M.E. Ritke, J.G. Babb, and R.D. Semlitsch, Memphis State University.

Observations were made on the gray treefrog (*Hyla versicolor*) from 1 July to 18 August 1987 in Shelby County, Tennessee during periods of reporductive activity. Measurements (snout-ischium length, head width, tibia length, and weight) were taken from 68 male and 14 gravid female treefrogs. Females were significantly larger than males in all comparisons ($P < 0.05$). All treefrogs were toe-clipped for individual identification; 24 males and one female were later recaptured. Recaptured males did not lose weight during the duration of the study ($P > 0.05$). A correlation between the size of the male and female for 12 amplectic pairs provided no evidence of assortative mating ($r = 0.09, P = 0.39$). The results of this study suggest: (1) reproductive activities are not energetically costly to males or that males have enough time to replenish energy reserves between periods of reproductive activity and (2) intersexual selection plays little or no role in determining sexual dimorphism in this population based on observations during a single breeding season.

Herpetofaunal Communities of Ponds in Land Between the Lakes: A Preliminary Report, E.M. Twombly and A.F. Scott, Austin Peay State University.

Land Between the Lakes (LBL), a 68,000 hectare peninsula of land between the lower reaches of the impounded Cumberland and Tenenssee rivers, contains many small ponds that vary in character. Twenty-seven of these ponds, chosen via a two-step systematic-random process, are currently being studied to determine the composition of their herptile communities. Data are also being obtained on pond size, bottom type, fish populations, aquatic plants, nature of suroundings, plus the following physical characteristics: temperature, dissolved oxygen, pH, and conductivity. Sampling began in

August 1987 and will continue through the fall of 1989. All ponds are being visited three times per year, once each in spring, summer and fall. Qualitative sampling involves seining, dip netting and hand collecting. Sightings are also being recorded. Quantitative sampling involves the use of a "drop-box" technique. Thus far, the best represented and most frequently encountered species have been *Rana catesbeiana, Rana sphenocephala, Gastrophryne carolinensis, Acris crepitans, Bufo woodhousei, Ambystoma maculatum, Notophthalmus viridescens, Nerodia sipedon,* and *Nerodia erythrogaster.* Final results of this study should add to an understanding of the following concerning pond-based herpetile communities in LBL: species composition, relative abundance, and variability associated with such factors as surrounding cover, bottom type, cohabitant fish populations, and type and extent of aquatic vegetation.

Distribution and Status of Endangered Bats in Tennessee, T.E. Pride and M.J. Harvey, Tennessee Technological University.

Fourteen species of bats occur in Tennessee. Two species, *Myotis sodalis* (Indiana bat) and *M. grisescens* (Gray bat) are listed as endangered by both the U.S. Fish and Wildlife Service and the Tennessee Wildlife Resources Agency. Populations of both species have declined during recent years. During the winter and summer of 1986, we visited caves known to be inhabited by either species and estimated population sizesof hibernation and summer colonies. Four caves were found to serve as gray bat hibernacula with a total of 299,940 bats. The gray bat summer population was estimated to total between 200,000–250,000 bats at 24 sites (23 caves and a dam). Twelve caves were found to contain a total of 22,398 hibernating Indiana bats. Several caves have been posted, fenced, or gated to protect gray bat and Indiana bat colonies.

An Estimate of Coyote Density in Western Tennessee, J.G. Babb and M.L. Kennedy, Memphis State University.

Density of the coyote (*Canis latrans*) was studied in Gibson and Carroll counties in western Tennessee from 6 January 1986 to 11 March 1986. The study was conducted on an upland forest site on the Milan Army Ammunition Plant. Thirty-four (18 males, 16 females) coyotes were taken using traps or snares. Minimum density averaged 0.35 coyote per km².

A Technique for Ageing White-Tailed Deer in Tennessee, C.J. Mitchell, B.L. Capps, W.P. Smith and S.A. Goss, Tennessee Technological University.

A sample of 20 permanent, lower second premolars were extracted from jaws of harvested deer, decalcified

for 2–3 days in a solution of 0.7 g ethylenediamine-tetraacetic acid and 0.2 g sodium tartrate in 1 L of 10% hydrochloric acid. Teeth were embedded in celloidin and histologically prepared with a sliding microtome and toluidine blue. Age of each deer was determined by enumerating the number of cementum annuli and adding one year (permanent second premolars erupt near 18 months of age) to the total. When compared to tooth wear and replacement estimates, 35% (7/20) of the deer were assigned different ages; the tooth eruption and wear technique consistently underaged deer. Teeth from known age deer are currently under examination to determine the reliability of the cementum annuli technique to provide accurate age structure data for trophy deer management in Tennessee and the Southeast.

A Phylogenetic Analysis of the Recent Procyonid Genera, D.M. Decker and W.C. Wozencraft, Memphis State University.

A phylogenetic analysis of the Recent procyonid genera was performed using PAUP; the analysis was based on 65 cranial, 28 dental, 10 postcranial and 26 soft morphological characters. The most parsimonious phylogenetic tree (Consistency index = 0.725) grouped *Ailurus* with the Ursidae and supported two monophyltic clades within the Procyonidae. *Bassaricyon* and *Potos* comprised the first branch, while *Bassariscus, Procyon, Nasua,* and *Nasuella* formed the second clade. *Bassaricyon* and *Potos* shared 20 synapomorphies, among them a relatively ininflated auditory bullae, reduction of dental cusps, and features of the petrosal and ear ossicles. Synapomorphis that unite *Bassariscus, Procyon, Nasua,* and *Nasuella* include the palatine inflation of the orbital wall, the presence of a hypocone on P4 and M1, and an entoconid on m2.

Winter Abundance of the Raccoon Procyon lotor *in a Western Tennessee Wetland,* J.P. Nelson, Jr., F.W. Weckerly, and D.W. Sugg, Memphis State University.

During the winter of 1987, raccoons (*Procyon lotor*) were studied in a wetland habitat on Reelfoot National Wildlife Refuge in western Tennessee. Animals were live trapped, marked, and released on an 8 × 11 grid. Traps were spaced approximately 200 m apart and baited with fish. A total of 2288 trap-nights were accumulated during the study. Forty-four raccoons were captured. There was a total of 47 recaptures. The number of animals within the sampled area was calculated to be 63, with a density of 1 raccoon/8.5 ha. Analysis of habitat variables associated with successful trap sites indicated that the number of fallen logs in the immediate vicinity of the trap was significantly correlated with presence of raccoons, and the number of standing snags (dbh 20–50 cm) approached significance.

Preliminary Report on the Food Habits of the Nine-Banded Armadillo Dasypus novemcinetus *in Southwest Arkansas,* R.S. Sikes, Memphis State University, G.A. Heidt, and J.L. Matthews, University of Arkansas at Little Rock.

Food habits of the nine-banded armadillo (*Dasypus novemcinctus*) were examined in Little River County, Arkansas. Twenty-two armadillos (19 males; 3 females) were collected from October 1986 through January 1987. All specimens examined were adult size and were foraging when taken. Stomach contents were analyzed for food items present, percent occurrence, and percent volume. Food items observed were primarily invertebrates (earthworms, beetle larvae, fly larvae) but vertebrates (young mice, frogs, salamanders, skinks) and plant material were present in some individuals.

A Rigorous Field Technique for Estimating Clutch Size in Eastern Wild Turkey: Preliminary Results, W.P. Smith, J.H. McGuiness, and S.C. Beason, Tennessee Technological University.

Fifteen clutches containing 84 eggs were collected from Louisiana and Mississippi in 1986. Eggs were dried using a GCA Precision mechanical convection oven at 95° C. Width, shell thickness, and longitudinal length of individual eggs were measured with a vernier caliper and the total dry weight of each clutch was recorded. Analyses of variance indicated significant variation existed among clutches. Width of eggs from central Mississippi (4.305 cm) differed from one clutch in southeastern Louisiana (4.785 cm); overall mean was 4.464 cm. Thickness varied even more with significant differences occurring among regional populations; means ranged 0.0423 – 0.0501 cm. Length from 3 clutches (n = 10) averaged 5.741 cm. Mean dry weight and 95% confidence interval was 6.62 ± 0.36 grams ($s^2 = 0.42$). These data indicate that standardized mean weight can be a reliable technique for obtaining rigorous estimates of clutch size in eastern wild turkey. However, existing variation within and among clutches and populations suggest that standardized mean weight should be determined for local populations, or a minimum sample of 40 clutches will be required to generate reasonable confidence intervals and unambiguous estimates of clutch size.

ZOOLOGY SECTION II
James M. Olcese, *presiding.*

The Effects of Ethylene Dibromide on Hydra oligactis: Parent and Offspring Toxicity Study, B.A. Wilson, and J.A. Adams, Tennessee State University.

Ethylene Dibromide (EDB) has become increasingly

prevalent in the environment due to its uses as soil, fruit, and grain fumigants, lead scavengers in petrol, and industrial solvents. As a result, EDB can be found in various foodstuffs including cereals and fruit. Animal tests indicate that it is a carcinogen, mutagen, and causes reproductive problems. Although controversial, data has closely linked EDB to mortality in humans (a total of 7 deaths) as established on two separate occasions in EDB manufacturing plants located in Michigan and Texas. Because of its increasing environmental prevalence and its proposed toxic effects (possibly lethal), this study explores the general toxicological effects of EDB on Hydras, parents (P1) which have been pre-exposed to an established sublethal concentration (one order of magnitude below the 72 hr LC50 for this species) for 14 days. The effect of non-exposed offspring (F1/P2) taken from pre-exposed parents (P1) versus their untreated offspring (F2) will also be evaluated. This mortality study revealed that the LC50 of both parents and F1's shifted from 50 mg/L, to 106.25 mg/L and 118.75 mg/L respectively, which suggest that exposed Hydras possibly become more tolerant to EDB. In the F2 generation, after 48 and 72 hrs 10% mortality was observed in the 200 mg/L group, 30% at 250 mg/L and 20% at 300 mg/L which indicated that the resistance to EDB toxicity is inheritable. There is also a strong dose-response correlation between EDB concentration and mortality.

Effects of Polychlorinated Biphenyls (Aroclors 1254 and 1016) on Fertilization Efficiency in Arbacia punctulata, R. Childress and J.A. Adams, Tennessee State University.

This study examined the effect of exposure of the eggs of the purple sea urchin *Arbacia punctulata* to two of the commonly-occurring commercial polychlorinated biphenyl (PCB) mixtures, Aroclors 1254 and 1016. Eggs were exposed to PCB's 25 minutes prior to insemination and continuously thereafter. The PCB's were administered as a component of a filtered–sea-water medium (FSW). Since *Arbacia* eggs cleave synchronously following insemination, the percentage of eggs cleaving at 1.75 hr post-insemination was used to determine the fertilization efficiency. Toxicant concentrations 0.5, 1.0, 5.0 and 10.0 mg/L were employed for both Aroclors. A FSW control and a FSW-acetone control was employed since acetone was used in a 49:1, acetone:PCB ratio, to emulsify the PCB's. Differences in control and PCB exposed groups were tested using Chi square at a 95% level of confidence. Both PCB's affected the fertilization efficiency once the threshold was achieved. The Aroclor 1016 proved to be much more toxic than Aroclor 1254. These results agree with the data previously achieved using *Hydra ologactis* as the experimental organism. Supported by NIH-DRR 08092.

Effects of Aroclors 1016 and 1254 on Morphogenesis of the Pluteus in Arbacia Punctulata, J.A. Adams, Tennessee State University.

Arbacia eggs were exposed to both Aroclors 1254 and 1016 at concentrations of 0.5, 1.0, 5.0 and 10.0 mg/L. Exposure was initiated 25 minutes prior to insemination and was continuous for the 72-hour observation period used in this study. A Filtered–Sea-Water (FSW) control and an acetone-FSW control were studied. Four morphological categories were used to describe the development of the embryos at 24, 48 and 72-hour intervals: These categories were normal pluteus (p), deformed pluteus (dp), transparent and disintegrating (t/d), and gastrula (g). A two-tailed T-test was employed to test for significant differences in distribution of the four categories studied. Both Aroclors caused significant dysmorphogenesis of the *Arbacia* embryos, however, at equal concentrations Aroclor 1254 was more lethal. Supported by NIH-DRR 08092.

Pharmacological Enhancement of Serotonin-like Immunoreactivity in Limulus, B. McAdory, R.F. Newkirk, Tennessee State University.

The biogenic amine serotonin has been demonstrated in the nervous tissues of the horseshoe crab *Limulus polyphemus* and a neorotransmitter role has ben suggested for it. The purpose of this study was to enhance the immunoreactivity of the serotonergic fibers and cells of the abdominal ganglia of *Limulus*. Whole mount preparations of paraformaldehyde-fixed abdominal ganglia that were pretreated with 5,7-dihydroxytryptamine for 5 days were studied using techniques of immunocytochemistry. Tissues were incubated in anti-serotonin antiserum, rinsed, and then incubated in goat anti-rabbit anti-serum labeled with fluorescein isothiocyanate (FITC). The preparation was mounted on glass slides and then viewed using an Aus Jena fluorescent microscope equipped with a 410/510/570 multiple excitation cube. The results of this study revealed a small number of fibers (approximately a dozen) which extended the length of the ventral nerve cord. An extensive plexus of fibers and a pair of cell clusters were observed in each ganglion (approximately 6 cells per cluster). However, large numbers of fibers were not observed to run in the ganglionic roots. Similar results were observed when the nervous tissue was pretreated for three to five days with the monoamine oxidase inhibitor pargyline and with colchicine, an inhibitor of microtubules. In particular, the same pattern of cell clusters in each ganglion was observed. These results strongly suggest that serotonin is localized in cells and nerve fibers of the abdominal ganglia of the horseshoe crab where it may serve as a central neurotransmitter. Supported by NIH grant SO6 RR 08092-13.

Using Satellite Data Communications and Automated Biomonitoring to Assess the Effects of Acid Precipitation on Rainbow Trout Salmo gairdneri *Breathing Rates*, L.D. Turner, J.F. McFadden and E.L. Morgan, Tennessee Technological University.

Satellite data communications and automated biomonitoring were used to assess the effects of acid precipitation on rainbow trout breathing rates in a remote second order stream in the Southern Appalachians. Two data collection platforms equipped with portable computers were used to record the breathing rates of rainbow trout the first and third quarters of each hour, while pH, temperature, dissolved oxygen, conductivity, and flow were recorded once each hour. These data were transmitted via earth satellite (GOES) every three hours and received at a local direct readout ground station maintained by the U.S. TVA. Interpretation of data appears to show a trout diurnal response curve. Preliminary results have shown that there is a complex relationship between the pH hydrograph and breathing rate: (1) at the onset of the rain event pH was 5.5 and breathing rate increased substantially and (2) during sustained high flow the pH increased and the breathing events fall below normal.

Distribution and Species Richness of Mussels in the Big South Fork National River and Recreation Area, Tennessee and Kentucky, S. Bakaletz and W.P. Smith, Tennessee Technological University.

During October 1985 to May 1986 and August 1987 unionids (*Mollusca*) of the Big South Fork and tributaries were inventoried by hand-picking shells and inspection while floating in a canoe or jon boat. A total of 37 man days of field investigation along 66.5 river miles (106.4 km) of the Big South Fork and tributaries resulted in the location and identification of 22 mussel species. Distribution and abundance varied for all mussels with a general trend of fewer species (S = 4) in the upstream-headwater area and more species (S = 17) at the most downriver location. Four federally protected mussel species were found; two species (*Villosa trabalis* and *Epioblasma walkeri*) are listed with the U.S. Fish and Wildlife Service as endangered species. The other two (*Pegias fabula* and *Alasmidonta atropurpurea*) are porposed to be listed as endangered species. One location, Oil Well Branch, supported all four species, as well as 16 additional species, the highest species richness recorded in this study. Field determinations identified clay as an element present in the substrate that may provide stability for mussel habitat. Protection of the mussel community at Oil Well Branch is recommended because the habitat was observed to be unique.